AD-A060 052 FORD AEROSPACE AND COMMUNICATIONS CORP PALO ALTO CALI--ETC F/G 9/2

SATELLITE DATA MANAGEMENT USER TERMINAL INVESTIGATION. VOLUME 1--ETC(U)

JUN 78 F04701-77-C-0094

UNCLASSIFIED WDL-TR7845 SAMSO-TR-78-23 NL

1 OF 1

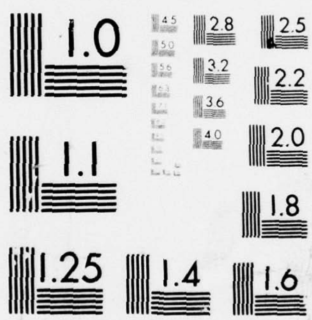
AD A060052

END

DATE FILMED

12-78

DDC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-

SAMSO-TR-78-23 (1) **LEVEL** II

WDL-TR7845
June 1978

AD A0 60052

(6)

SATELLITE DATA MANAGEMENT USER TERMINAL INVESTIGATION.

VOLUME 1: EXECUTIVE SUMMARY.

(9) Final rept. Apr 77-May 78.

(11) Jun 78 (12) 19p.

(14) WDL-TR-7845

(15) F04701-77-C-0094

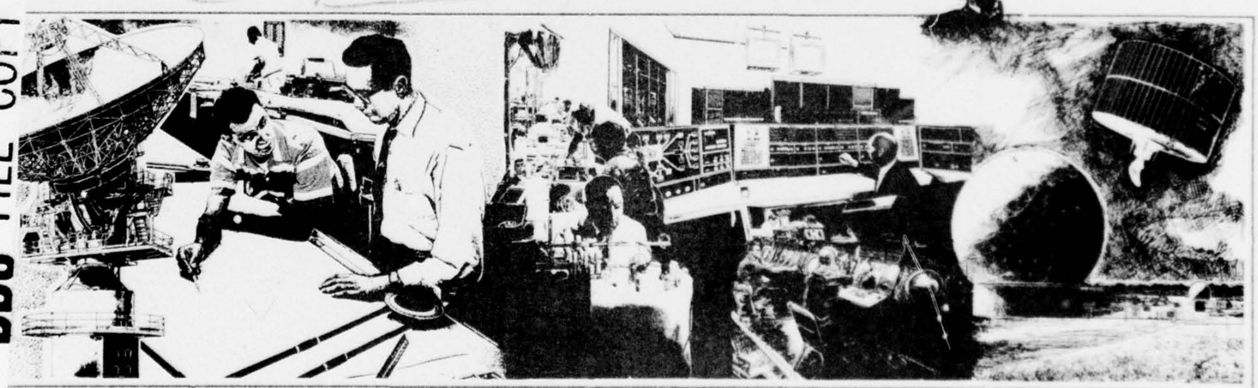
D D C
RECEIVED
OCT 19 1978
B

Prepared for:

Air Force Systems Command
Space and Missiles Systems Organization, YCPC
Los Angeles, California

(18) SAMSO (19) TR-78-23

DDC FILE COPY



Ford
Ford Aerospace &
Communications Corporation
Western Development
Laboratories Division

3939 Fabian Way
Palo Alto, California 94303

78 10 10 083

409 337

JOB

This final report was submitted by Ford Aerospace and Communications Corporation, Western Development Laboratories Division, Palo Alto, Ca., under contract F04701-77-C-0094, with Headquarters Space and Missile Systems Organization (AFSC), P O Box 92960, Worldway Postal Center, Los Angeles, Ca., 90009. Captain Robert C Blakely, SAMSO/YCPT, was the project officer.

This report has been reviewed by the Information Office (OI) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication. Publication of this report does not constitute Air Force approval of the report's findings or conclusions. It is published only for the exchange and stimulation of ideas.

Robert C. Blakely
ROBERT C BLAKELY, Captain, USAF
Program Manager

Kenneth E Needham
KENNETH E NEEDHAM, Major, USAF
Chief, Technology Plans Division

FOR THE COMMANDER

Leonard E. Baltzell
LEONARD E. BALTZELL, Col., USAF
Asst Deputy for Advanced
Space Programs

WDL-TR-7845 June 1978

SATELLITE DATA MANAGEMENT USER TERMINAL INVESTIGATION

VOLUME 1: EXECUTIVE SUMMARY

Final Report for the period April 1977-May 1978,
Contract No. F04701-77-C-0094

Approved for Public Release: Distribution Unlimited

Ford Aerospace and Communications Corporation
Western Development Laboratories Division
Palo Alto, CA

Prepared for:

Air Force Systems Command
Space and Missiles Systems Organization (YCPC)
Los Angeles, CA

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: SAMSO TR-78-23	2. GOVT ACCESSION NO.
	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): SATELLITE DATA MANAGEMENT USER TERMINAL INVESTIGATION	5. TYPE OF REPORT & PERIOD COVERED
	6. PERFORMING ORG. REPORT NUMBER: WDL-TR-7845
7. AUTHOR(s)	8. CONTRACT OR GRANT NUMBER(s): F04701-77-C-0094
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Ford Aerospace & Communications Corp. 3939 Fabian Way Palo Alto, CA 94303	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: Space and Missile Systems Organization/YC P.O. Box 92960, Worldway Postal Center Los Angeles, CA 90009	12. REPORT DATE: June 1978
	13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release: Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Command and Control; Human Factors; Satellite Data Management; Simulations; Man-Machine Interaction; Satellite Terminals; Information Processing; Decision Functions

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This study surveys, analyzes and defines the critical issues associated with future Satellite Data Management Terminals, looking into the time period to 1990-2000. It takes its principal perspective as that of directly supporting the individual operational or tactical commander in his performance of missions for which satellite data of any sort will be used. The study assumes a broad, explicit mission set and addresses several related questions: What is the nature of the operational/tactical commander who will use the

Block No. 20 (cont.)

terminal? What are the information handling requirements that result? Inquiry into the state of the art and forecasts of advanced technologies applicable to the terminal lead to conclusions regarding possible terminal configurations. An initial conceptual definition of possible advanced terminal simulation, including characterization of the commander, is included. Indirect measurement parameters for assessing the terminal contribution to command mission decision performance are suggested.

EXECUTIVE SUMMARY

A study was performed over the last year that examined the critical issues involved in developing a satellite data management terminal designed to be used directly by tactical commanders themselves. The terminal would be expected to be useful in support of a broad range of missions and command responsibilities that depend upon satellite-delivered mission information. (See Figures 2-2 and 4-1, following.)

The study took as its planning horizon 1990-2000; it made conservative projections regarding hardware and software technology; and it reviewed DoD industry anticipations regarding the types, rates and needs for satellite-ground data flow.

This terminal study is a part of the Satellite Data Management Program, which has been studying "the orderly interaction of the sensor, the communications network, and the user terminal capabilities to satisfy the user information requirements for the 1990-2000 time frame...The overall study strives to recognize the emerging potential of decentralized data processing and the impact of technological advances."*

Problems

Questions that initiated this study included the following:

1. What type of human model can be used to represent a tactical commander?

2. How would we functionally characterize future terminals?

---

* Par. 2.1, SOW, Contract F04701-770C-0094

FIGURE 4-1

SATELLITE DATA MANAGEMENT TERMINAL

SUMMARY FUNCTIONAL DIAGRAM

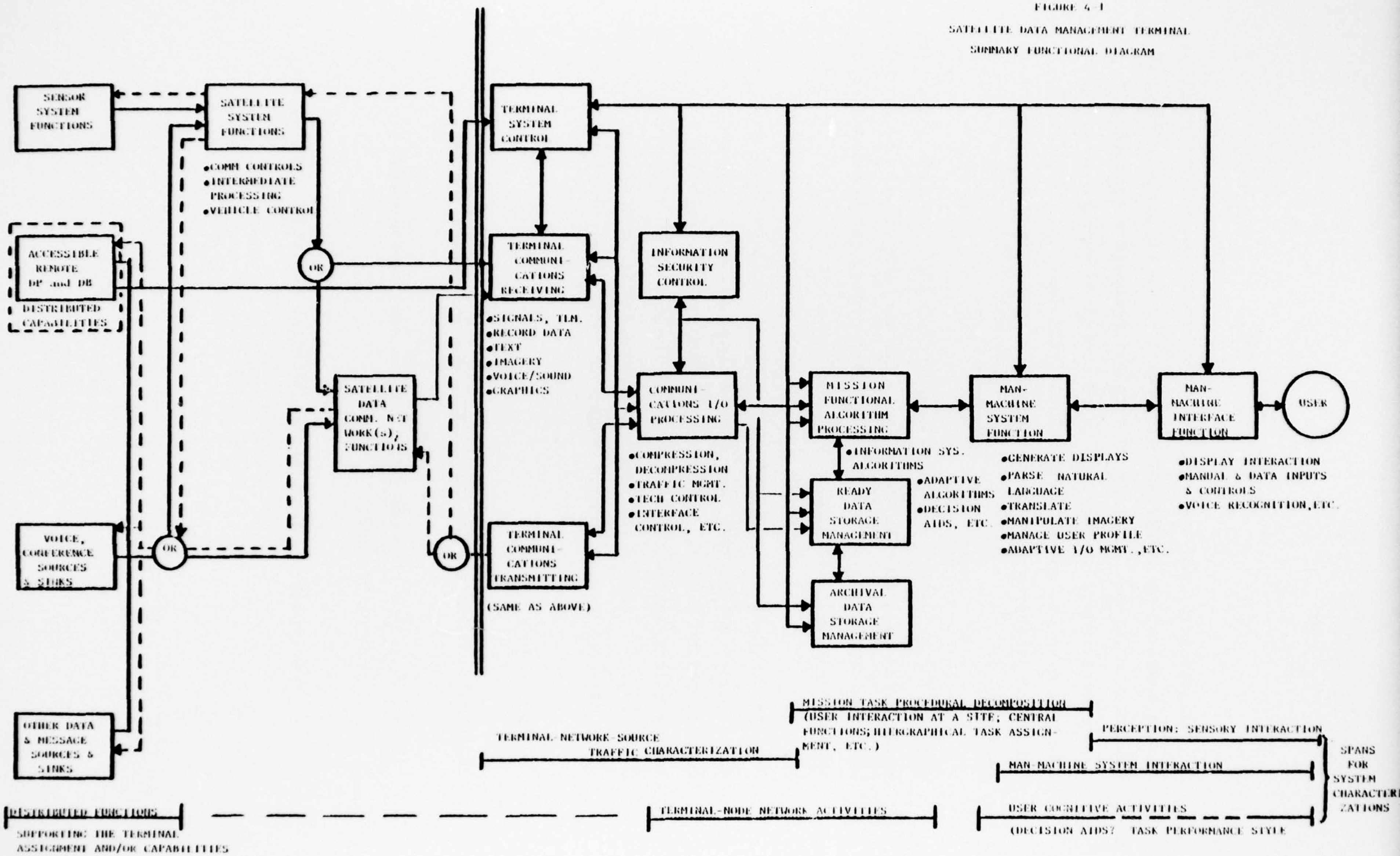
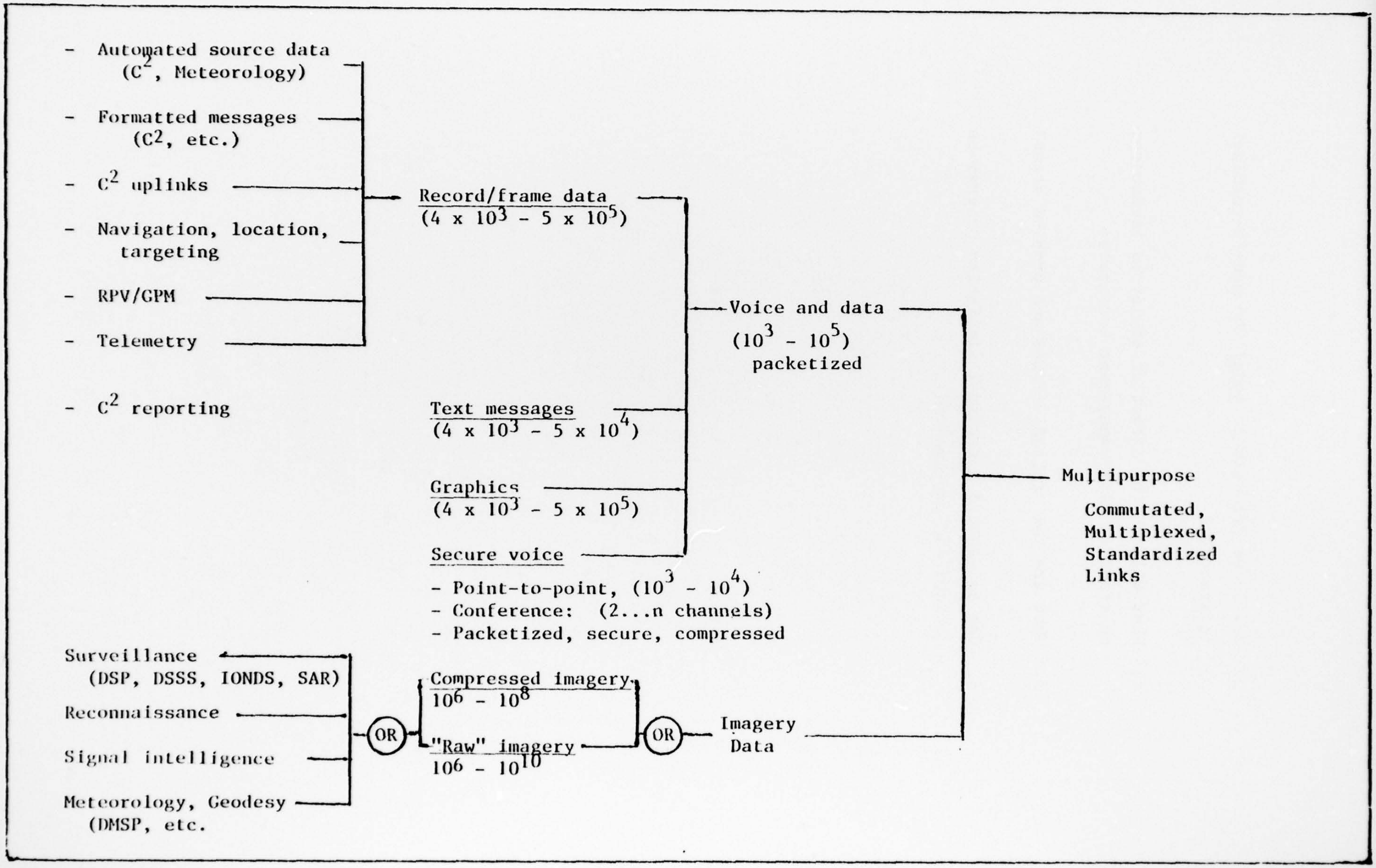


Figure 2-2

SDMT DATA I/O RATES

(in bits/sec)



3. How do we effectively <u>model</u> the man-to-terminal interaction?

4. What will be the effect of projected technology on standard data management terminals?

5. What are the critical issues and problem areas?

6. Can and should a terminal simulation program be defined and implemented?

Findings, Conclusions and Recommendations

1. The military reasons for seeking a compact, high-performance, broadly applicable equipment system to serve as the terminal for the satellite data networks are so well understood that to detail them would be superfluous: C^2 interoperability, operational efficiency, and logistic efficiency are major categories applicable. It is a conclusion of this study that processor equipment technology and processor system software will, in a very few years, allow development and deployment of modular satellite data management terminals for a wide variety of mission support functions at a wide variety of echelons:

   a. Solid state very large scale integration (VLSI) coupled with large, high-speed solid state mass memories are under development. They will be so cheap, relative to the other parts of an SDMT system (such as software, communications and MMI equipment), that distributed processing systems delegating processing functions to dedicated and special purpose "super-microprocessors" will be highly cost-effective. (Vol. 2, Par. 4.2, 4.3)

   b. Major government and industrial investment in distributed system architecture and control software will result in effective and possibly fairly standardized software, interfaces and linking busses. (Par. 4.3)

2. However, to field operational systems to be used by tactical (operational) commanders themselves for broad support of their decision activities, major developments in a number of research fields must be successfully concluded:

a. A comprehensive and valid model or theory of how cognitive decision processes function is needed. Without it, numerous adaptive, interactive decision aids may be brought to operational status but will serve only special-purpose mission support requirements. Such an advance would be in the nature of a breakthrough. (Par. 3.2, 3.3)

b. To be an acceptable device at the man-machine interaction level, the terminal will need to employ effective natural language understanding software and probably continuous voice recognition software. In addition, much more cost-effective displays should continue to be sought after, to provide wide-area, high-resolution dynamic output. (Par. 4.2)

c. A great deal of research is needed to develop an effective understanding of the behavioral psychology of commanders before we can make use of truly adaptive artificial-intelligence concepts to automate decision support functions. (Section 3)

d. There is a need, not confined to SDMT systems, for intensive study of how to present well-integrated information on dynamic visual displays. A new symbolism will have to be developed, tested, psychologically validated, and broadly promulgated, so that trained commanders perceive and utilize delivered information efficiently, and so that command level intercommunication is made maximally effective. (Par. 4.4.4)

The following are recommendations supporting the above conclusions:

a. That SAMSO express continuing needs for operational results from R&D now underway, to the cognizant DoD, AF, AFSC, or SAMSO research management organizations:

- o Militarized VLSI for processors
  fault tolerant
  special architectures (associative, array, list)

- o Solid state non-volatile memories

- o Advanced encrypting

- o Command behavior psychology
  cognitive styles
  decision behavior

- o Data fusion, automated data base management and advanced query systems, inference logic applications.

- o Decision aid systems; esp. adaptive and interactive

- o Advanced communications systems
  RF
  optical

b. That SAMSO provide direct technical interaction with organizations engaged in projects of specific and immediate value to the SDMT program.

- o Distributed processing systems architecture, and techniques for evaluating, measuring or estimating configuration performance.

- o 2D, pseudo-3D and 3D display systems (dynamic)

- o Voice recognition

- o Natural language understanding
- o Display integration/design - development of meaningful conventions for thematic abstract pseudo-3D and 3D displays
- o Development of information theory techniques for mission information effectiveness evaluation (uncertainty and recoding)
- o Information recoding analysis
- o Video conferencing
- o Automated message handling
- o Voice/data conferencing
- o Distributed data base systems

c. That SAMSO define and accomplish R&D to provide results needed specifically for the SDMT.

- o Hierarchical distributed processing systems using VLSI and high-speed mass memories, structured for modularity and functionally dedicated subsystems
- o Software architecture for distributed processing management for the SDMT
- o Methods for introducing automated support to operational commanders; training and exercise requirements research
- o Top-down SDM-supported mission task and command analysis to determine information requirements. (How much is needed vs how much is wanted.)

3. A well-focussed program of SDMT system simulation is feasible, can be highly cost-effective, and can be used to answer a large number of critical development questions.

A three-phased implementation program is suggested in the final report (Par. 5.1), with the following objectives:

(1) To propose alternative SDMT architectures and test their behavior and performance under various simulated mission task loads.

(1.a) To estimate how advanced technology will perform. To simulate using distributed VLSI architecture, high-speed solid state memory, bus configurations and dedicated subsystems in configurations supporting broad mission task sets.

(1.b) To estimate and validate the effect of incorporating advanced MMI and communications subsystems.

(1.c) To test implementation concepts for functional commonality achieved through modularity.

(2) To evaluate the probable performance of proposed new technological developments in software. This objective could overlap objectives related to human mission performance, and its implementation would require careful discrimination of test objectives; i.e., is the machine testing the man, the man testing the machine, or the total man-machine performance being evaluated?

(3) To provide a basis for cost estimating for alternative incremental development--deployment--enhancement programs.

(4) To evaluate the effects of mission assignment workloads on postulated systems. This would require a change in test perspective, to hold simulated configurations stable while investigating the needs of mission support tasks.

(5) To investigate the performance of commanders using proposed advanced capabilities. There are several aspects to this major objective:

(5.a) To determine the facility with which commanders could make use of advanced MMI subsystems. Transparency and acceptability would be principal system design objectives.

(5.b) To determine the ease with which commanders could make use of logical decision function aids (decision aids, information aids, etc.)

(5.c) To test the acceptability of proposed very advanced information handling capabilities such as deductive and inductive inference subsystems.

(5.d) To measure and relate commanders' human performance of (simulated) mission tasks to advanced functional capabilities. This objective presupposes modeling of the decision process and information requirements. It anticipates attempts to validate behavioral decision-making theories applicable to SDMT mission needs.

(6) To provide the prototype for evaluating training requirements for SDMT users. Proposed requirements for training including hardware, software and drivers (scenarios, games, etc.) can be validated. If the simulation system later incorporates users for test, it could be considered also as a prototype training resource in itself.

4. Although neither this study nor other current research has established direct quantitative relationships between satellite link data rates and commanders' mission performance, three reasonably objective measures for evaluating the relationship of mission information to mission performance are suggested (Vol. 2, Par. 3.3.3) By name they are:

   a. Use of uncertainty measures

   b. Evaluation of recoding effectiveness

   c. Time efficiency measurements

   It is recommended that attempts to made to apply these at R&D levels to determine their feasibility.

5. More detailed mission analysis to establish commanders' information needs is required in order to allow quantitative alternative terminal configurations to be synthesized and evaluated or simulated. (Par. 1.1.2)

6. To provide SAMSO with continuous planning control over satellite network options, a third level of simulation activity, intermediate between SDMT and the network topology/traffic simulation, seems required. (Par. 5.5)

Sources for the Conclusions: Study Approach

The study team postulated a possible program to define and implement a satellite data management terminal for the individual use of command-level personnel performing mission tasks using space-borne resources. The terminal was to have a commonality of design and a high level of decision function automation. Special emphasis was placed on requirements to make the terminal functionally effective and personally useful to the commander in support of his mission decision functions. Figure 1-1 (next page) is an objective tree used to provide rough guidelines to the study.

The study team consisted of FACC Special Programs Operations Systems engineers supplemented as required by human factors specialists, equipment and software engineers and professional OR/Simulation personnel. The team performed the study efforts in two phases. The initial statement of work covering an investigation into future missions, data flows, technologies and decision aid research. The initial phase also called for a characterization of tactical commanders in respect to their need for and use of satellite mission data. The second phase of the study addressed the command processes to be supported by the terminal, to determine (1) if a suitable means to quantitatively relate the data delivered on the satellite network to the performance of mission functions could be defined; and (2) if appropriate criteria to be used as guidelines for automating decision function support could be defined. Phase two also concluded inquiry to the usefulness and feasibility of establishing a program to simulate advanced satellite terminal configurations.

The study team determined the state of the art and the courses being taken by research organizations in the technologies applicable to the terminal concept by extensive discussions with in-house,

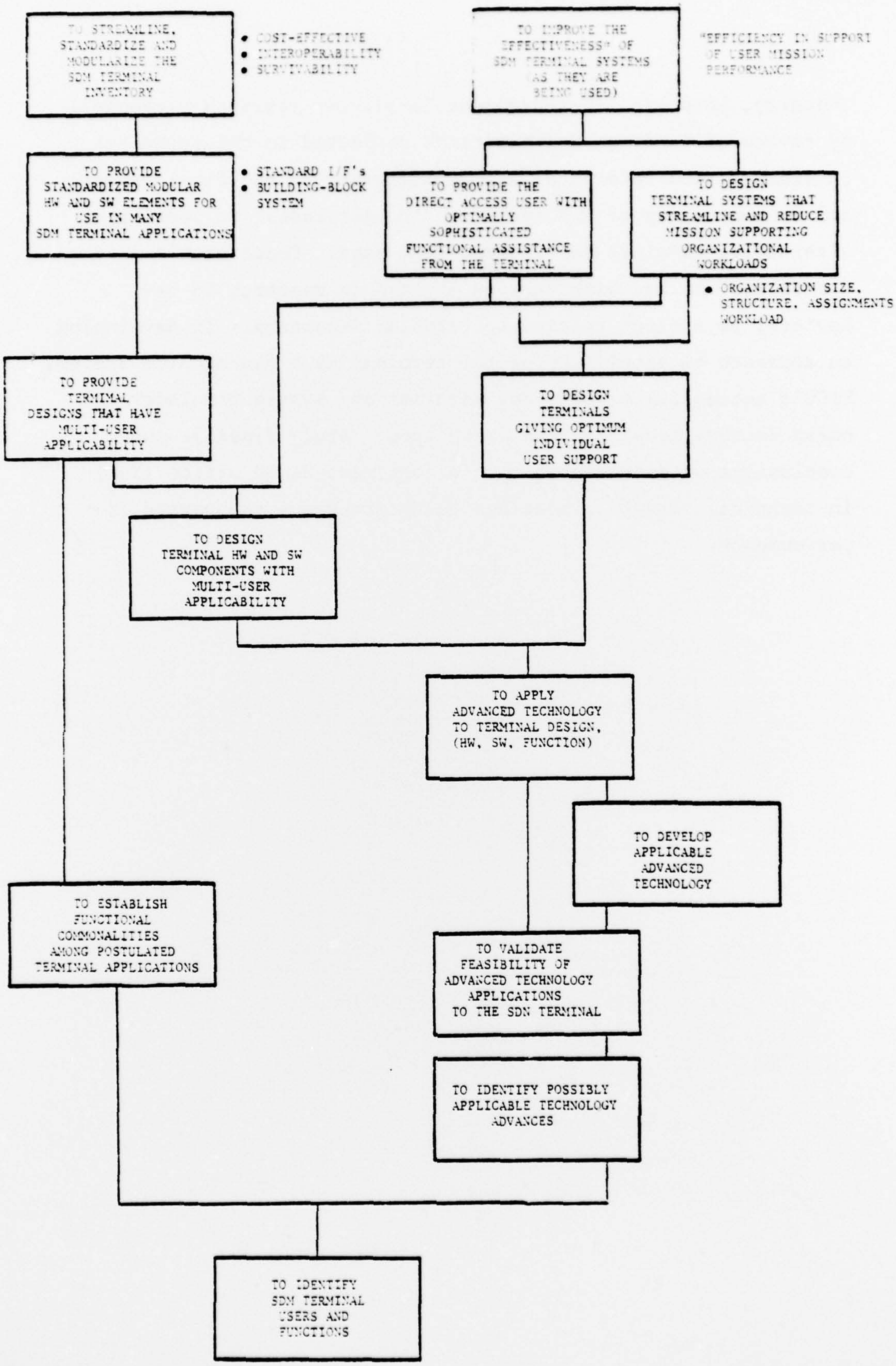


FIGURE 1-1 SUGGESTED PARTIAL OBJECTIVES TREE
SDM TERMINAL DEVELOPMENT PROGRAM

industry, academic and government laboratory research personnel; by review of findings and positions reflected in the technical literature (See references and bibliography in the final report); and by conceiving of and applying "thought tests" to possible alternative terminal development road maps. Considerable discussion was had with persons engaged in research in behavioral psychology related to terminal interests. In developing an approach to simulation of the terminal as a man-machine system, FACC's successful experiences with its own system simulator and human factors modeling were drawn upon. Study findings and conclusions were presented to the cognizant SAMSO office (YCP) in technical direction meetings held throughout the period of performance.

ED

-78